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Prevalence of Problematic Cocaine Consumption in a City of Southern Europe, Using Capture–Recapture with a Single List

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ABSTRACT *This study aims to determine the magnitude and characteristics of problematic cocaine consumption in the city of Barcelona, Spain. Capture–recapture with a single source was used to estimate prevalence. Log-linear regression models with interaction terms were fitted to the total sample and to subgroups according to other drugs consumed. Emergency room indicator data were obtained from the Barcelona Drug Information System. Drug-related emergencies of Barcelona residents for 1999 were analyzed. During 1999, a total of 4,035 drug-related emergencies were seen in Barcelona hospitals. Of these, 1,656 (41%) involved cocaine consumption; 41% of these patients had consumed cocaine with an opiate; 29% used cocaine with other substances; and 30% used cocaine alone. It was estimated that there was a total of 25,988 problematic cocaine users (95% confidence interval 11,782–58,064), yielding a rate of 31.27 per 1,000 inhabitants aged 15 to 54 years (95% confidence interval 14.2–69.9). The number of cocaine-related emergencies was high enough to allow capture–recapture to be applied, thus obtaining an estimate of the prevalence of problematic cocaine consumption, and high enough to characterize users according to different profiles. The use of capture–recapture with a single source can be interesting for problems related to the urban context.*

KEYWORDS *Capture–recapture, Cocaine use, Emergency room.*

INTRODUCTION

Since the beginning of the 1990s, cocaine use has been an important health problem throughout Spain.[1] This fact has been brought to light by surveys on drug consumption, which showed a rise in prevalence among the general population between the ages of 15 to 64 years,[2] as well as among young adults aged 15–34 years.[3] The supply also increased, as shown by a rise in police seizures.[2]

Within the European Union, treatment data showed that Spain has the highest figure of problematic cocaine use, followed by the Netherlands.[4] It is precisely in these countries where the shift toward cocaine use, its problematic consumption, and the number of police seizures have increased most in recent years.

In Barcelona, recent studies have reported the rise in problems related to cocaine, noting its increasing role in drug-related emergencies, drug treatment admissions, and drug-related deaths. By 1999, cocaine had become the first drug

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involved in each of these three indicators (Supraindex). The same holds true for patients in methadone maintenance programs, with 27% of those beginning treatment in 1997 admitting to having taken cocaine; in 1998, that figure was 40%.[6]

At the same time, several authors during the 1990s began calling attention to serious health problems related to cocaine use,[7,8] principally among those who smoked it or injected it with heroin.[9] Resulting complications occasioned frequent visits to emergency services. Some authors found a relation between consumption patterns among cocaine users and their medical problems, especially important are the other drugs consumed and the route of administration.[10–12]

Various authors have proposed different methods, categorized as either direct or indirect,[13–16] for measuring the prevalence of drug abuse. One of the most widely used in this field has been capture–recapture,[17–19] which despite its limitations, has proven to be one of the most adequate methods for estimating prevalence of elusive behaviors.[20–24]

Given the extent of the phenomenon, and with the aim of determining the magnitude and characteristics of problematic cocaine consumption in the city of Barcelona, we undertook this study to estimate problematic cocaine use prevalence from associated problems observed in hospital emergencies.

MATERIAL AND METHODS

Our data came from the Barcelona Drug Information System (SIDB), created in 1987 in accordance with the directives of the National Drug Information System.[2] These information systems are based on the gathering of systematic data from indirect indicators of psychoactive substance consumption. For the present study, we analyzed data from drug-related emergencies occurring in the city of Barcelona during 1999. A case was defined as any emergency with mention of cocaine use incurred by a Barcelona city resident at any of the four university city hospital emergency services plus Perecamps Hospital. In a previous study, these five emergency rooms covered 95% of opiate-related emergencies in the city.[25]

Variables analyzed were (1) administrative data from hospital emergency registers (name of hospital, date and time of admission, age, sex, area of residence); (2) extracts from emergency reports, with some variables self-reported by patients (drugs consumed, drugs causing the emergency, route of administration, and human immunodeficiency virus [HIV] status), type of emergency, reason for emergency, diagnosis, and destination on release. Reliability and validity of relevant variables has been reported elsewhere.[26] Proportional differences were measured by the chi-squared test. For continuous variables, we used analysis of variance.

To ascertain prevalence, the technique known as capture–recapture was applied. Capture–recapture is an indirect method of prevalence estimation based on the degree of overlap between two or more samples; it was first used by biologists to estimate the number of wild animals in a given area.[27] Capture–recapture with a single source was used by separating the full-year emergency register into three consecutive 4-month periods and considering each period as a different sample, as has been proposed in former studies.[28,29] Thus, the resulting estimate would reflect the cocaine-consuming population susceptible to come into contact with emergency services.

We analyzed reliability and internal coherence of emergency episodes data. A confidential identifier, consisting of the first three letters from the patient's two surnames, date of birth, and sex, was used to assess individual overlap between

the three consecutive samples. Then, we set up an algorithm that maximized the probability of unmistakably identifying an individual associated with an episode. With this previously validated algorithm, 97% of pairs were accurately detected, with greater than 95% sensitivity and specificity.[30] For those whom it was difficult to individualize under this system (e.g., a person with only one surname or a foreign surname), a manual check was carried out, and pairing was done when indicated. With the identifier, cases were ordered according to the degree of overlap among samples, that is, according to the presence or absence of each case within one of the 4-month periods. When an individual appeared more than once in the same 4-month period, he or she was only counted once.

To minimize heterogeneity in the capture, we stratified consumers by drugs other than cocaine mentioned in the emergency episode because patterns of drug use and their related problems could be different in each subgroup. Four drug subgroups were made: cocaine plus heroin; cocaine plus methadone; cocaine plus other psychoactive substances (alcohol, amphetamine, cannabis); and cocaine alone.

To estimate the unknown population, we fitted log-linear regression models for each of the aforementioned categories and for the total. Models with all possible combinations of interactions were fitted to adjust for possible dependencies between samples, allowing an evaluation of the best fit.[31] Only models with a good fit to the data were considered, and Akaike's information criterion (AIC) to choose single models[32] was calculated for all of them. A model was considered to fit data when the deviance did not stray from available degrees of freedom, and its residuals were small. In those drug subgroups in which a saturated model (zero degrees of freedom) could be fitted, estimates from this model were chosen; otherwise, the estimate for the unknown population was calculated by averaging AIC-weighted estimates from adjusted models.[19,33] Confidence intervals (CIs), including those for weighted estimates, were calculated by the method proposed by Regal and Hook.[34] The statistical package GLIM[35] (generalized linear interactive modeling) was used for modeling.

In calculating prevalence rates, Barcelona residents aged 15 to 54 years from the 1996 census[36] were taken as the denominator.

RESULTS

In 1999, there were 4,035 hospital emergencies related to the use of illegal psychoactive drugs among Barcelona residents. Of these emergencies, 1,656 (41%) mentioned cocaine. They corresponded to 1,402 individuals; thus, the average number of visits per year for these patients was 1.2. Frequency of contact varied according to other substances consumed, with the combination cocaine plus methadone the most frequent, with 1.5 visits/person/year; the least frequent was cocaine plus other substances, with only 1.03 visits/person/year (Table 1).

Table 1 shows the characteristics of hospital emergencies with cocaine mentions in Barcelona. Of all cases, 41% corresponded to the profile for cocaine and another opiate (cocaine plus heroin and cocaine plus methadone), which included the older consumers as well as those with the highest prevalence of cocaine injection (74.9%) and positive HIV status (44.9%). Organic complications (among which 60% were related to their HIV-positive status) and overdose were the most frequent reasons for seeking emergency room treatment.

The youngest population in the study was consumers of cocaine plus other substances, which accounted for 29% of cocaine emergencies. Their preferred route of administration was intranasal, and the other drugs consumed were alcohol

TABLE 1. Characteristics of emergencies with cocaine mentioned in Barcelona hospitals, 1999

	Cocaine + heroin (N = 541; 32.7%)	Cocaine + methadone (N = 142; 8.6%)	Cocaine + other (N = 477; 28.8%)	Cocaine alone (N = 496; 29.9%)	Total (N = 1,656)
Sex,*					
Women	22%	38%	29%	29%	27%
Age,* years					
Mean (SD)	30.6 (7.2)	32 (6.6)	28.9 (7.7)	30.7 (7.6)	30.3 (7.5)
Median	30	31	28	29	30
<25 years	24.7%	14.9%	36.6%	25.9%	27.7%
HIV*					
Positive†	34.2%	55.6%	6.7%	22.4%	24.6%
Negative†	65.8%	44.4%	93.3%	77.6%	75.4%
Unknown	(57%)	(34%)	(91%)	(73%)	(70%)
Route of administration*					
Injected	73.6%	80.2%	6.9%	38.1%	52.3%
Pulmonary	1.2%	1.0%	2.5%	0.4	1.2%
Intranasal	25.2%	18.8%	90.6%	61.5%	46.5%
Unknown	(13%)	(11%)	(64%)	(43%)	(30%)
Known by SIDB	80%	100%	0.9%	34%	52%
Episodes per person	1.27	1.43	1.03	1.20	1.18
Reason for emergency*					
Overdose	21.6%	18.3%	29.2%	12.1%	20.7%
Abstinence	6.8%	1.4%	1.5%	0.6%	3%
Organic complication	23.5%	42.3%	12%	27.4%	23%
Psychiatric	10.9%	18.3%	34.2%	24.6%	22.4%
External cause‡	7%	4.2%	3.8%	9.1%	6.5%
Others	30.1%	15.5%	19.3%	26.5%	24.5%

HIV, human immunodeficiency virus; SIDB, Barcelona Drug Information System.

* $P < .01$ between subgroups.

† Percentage among those patients with known status.

‡ Includes injuries and homicides.

(58.3%), cannabis (36.3%), and other stimulants (11.9%). Among reasons for emergency treatment in this group, psychiatric complications were the highest (34.2%), although overdoses were also quite frequent (29.2%); none of their organic complications were related to positive HIV serostatus.

The cocaine-alone group, 30% of emergencies, was the most heterogeneous, with high prevalences of injecting and positive HIV status. In fact, 34% of cases classified in this group had been previously known to SIDB as active or former consumers of heroin. Thoracic pain and tachycardia were their more frequent organic complications.

Individual overlaps between samples (4-month periods) for each of the drug subgroups and the total are shown in Table 2. When log-linear models were applied, independent models already fit the subgroup data well, except for the total that needed the saturated model to achieve a good fit. However, whenever the saturated model could be fitted, its estimate was preferred. For cocaine plus others and cocaine plus methadone, given that the saturated model could not be fitted and AIC identified the model without any interaction (independent model), the estimate taken for the unknown population in these two subgroups was the weighted AIC.

The estimated number of cocaine users susceptible to requiring emergency services between the ages 15 to 54 years in Barcelona in 1999 was 25,990 (95% CI 11,782–58,064) (Table 3). This yields an estimated rate of 31.27 cocaine users per 1,000 inhabitants in this age group (95% CI 14.18–69.9). Estimates were not evenly distributed in the different profile subgroups, with cocaine alone including the highest number of users, followed by cocaine plus heroin, cocaine plus other substances, and finally cocaine plus methadone.

The number of patients observed in hospital emergencies, the known cases, only represented 5.4% of the estimated total prevalence. Slightly lower percentages were seen for both cocaine alone and cocaine plus heroin. However, a higher percentage (10%–12%) of cocaine-plus-methadone and cocaine-plus-other substances subgroups had been captured by studied emergency room data.

DISCUSSION

Data on a hidden behavior like cocaine use is difficult to obtain from different sources to analyze its magnitude with a widely accepted method like capture–recapture with multiple lists. However, the acute nature of the problems related to its consumption can be caught in emergency room records. In the present study, the number of Barcelona's cocaine-related emergencies were high enough to allow application of capture–recapture with a single list. An approach to different subgroups of users was also sought, allowing estimates for different profiles of cocaine consumers to be obtained.

As capture–recapture is a good prevalence estimation method for small areas, its use with a single source can be interesting for different problems related to the urban context because it is usually difficult to find three or more sources of data as different captures. Other solutions, such as the use of two sources divided by time, have been used.[37] In an urban context, it is most valuable to know the magnitude and the characteristics of the problem to adequately define the objectives, to plan satisfactory resources, and, if necessary, adapt the resources already available to the current needs. The present study points out the importance of mental health problems among cocaine users in Barcelona and the lack of appropriate services in the city.

TABLE 2. Individual overlap in three period samples according to drug subgroup

	q1 yes, q2 yes, q3 yes	q1 yes, q2 yes, q3 no	q1 yes, q2 no, q3 yes	q1 yes, q2 no, q3 no	q1 no, q2 yes, q3 yes	q1 no, q2 yes, q3 no	q1 no, q2 no, q3 yes	Total
Cocaine plus heroin	3	9	7	109	13	139	146	426
Cocaine plus methadone	1	1	1	26	1	40	29	99
Cocaine plus other	1	6	6	129	6	157	160	465
Cocaine alone	2	8	7	103	8	145	139	412
Total cocaine	7	24	21	367	28	481	474	1,402

q1, first 4-month period; q2, second 4-month period; q3, third 4-month period.

TABLE 3. Estimated number of consumers by category of consumption pattern for selected models, Barcelona, 1999

		Population (no.)				Population rate†	
	Model	Known	Unknown	Estimate	95% CI	Estimate	95% CI
All cocaine	Saturated	1,402	24,588	25,990	11,782–58,064	31.27	14.18–69.86
Cocaine plus heroin	Saturated	426	8,103	8,529	1,828–40,404	10	2.20–48.61
Cocaine plus methadone	wAIC (4 models)	99	888	987	328–11,583	1.19	0.39–13.94
Cocaine plus other substances	wAIC (7 models)	465	3,471	3,936	2,485–7,138	4.74	2.99–8.59
Cocaine alone	Saturated	412	9,265	9,677	1,521–56,551	11.64	1.83–68.04

CI, confidence interval; wAIC, weighted Akaike's information criteria.

† Rate per 1,000 inhabitants 15–54 years old.

The estimated annual prevalence of problematic cocaine consumption found for Barcelona (31.3 per 1,000 inhabitants 15–54 years old) was high, although concordant with results from other studies. A nationwide survey in Spain in 1999 found that cocaine consumption for the previous year had been 6.6% among subjects 20–24 years old, and that between 1995 and 1999, there had been an increase of 29% in habitual consumption.[2] In 1992, for Barcelona city, a lifetime prevalence of 3% cocaine users in the population aged 15–64 years and 5% for those between ages 15 and 44 years was obtained in a snowball study.[38] By 2000, these prevalence rates, obtained through a health interview survey, were 3.4% for the group aged 15 to 64 years and 4.2% for those aged 15 to 54 years.[39] These estimates included nonproblematic consumption, which lends credibility to the figure of 3% problematic cocaine use estimated by the present study for Barcelona residents aged 15–54 years. Slight intercensus variations in the middle-aged population could not account for these differences in rates. In contrast, all estimates regarding opiate abuse in Barcelona in different years[19,40] yielded lower prevalence figures (0.9% and 1.4%, for 1989 and 1993, respectively) than those found here for cocaine.

These results lead us to believe that cocaine consumption is and has been more widespread than opiate consumption, even though until very recently it has been less visible and prompted fewer sociosanitary problems. This fact might be because of not only the lag time between the initiation of use—leisure and recreational—and the development of a pathology related to abuse, but also the mixing of cocaine and heroin illegal markets.

Some authors point to the route of administration of cocaine as the variable that accounts for greatest heterogeneity among users,[10–12] but in our study that variable was not available for all patients. Other drugs consumed could also be important determinants for heterogeneity among cocaine users and a proxy of route of administration. Several characteristics of studied emergencies support this thought (see Table 1). As homogeneity of capture is one of the assumptions to apply capture–recapture, we did the analysis separately by subgroups of other drugs consumed and the total. However, estimates were not so different whether analyzing the total or summing the results for subgroups.

Both approaches are useful because it is important to be able to calculate prevalence estimates for each profile group because it leads to the possibility of characterizing the phenomenon according to associated pathologies and patterns of consumption, and so that planning and intervention can be specifically targeted. In previous studies, the homogeneity assumption was dealt with through stratification by other factors, mainly age and gender.[19,28,41] We also explored these factors both separately and together with the other drugs consumed. Using the same selection criteria, estimates varied widely (from 14,053 to 36,607). When stratification by drug categories was done alone, the estimate obtained was closer to the nonstratified total estimate (Table 3).

In US studies, neuropsychiatric and cardiopulmonary problems were the more frequent complications observed for cocaine users, even among injectors.[10–12] However, in our population, infections related to positive HIV status were the most prevalent among cocaine-plus-opiate users (who were mostly injectors), reflecting the high prevalence of HIV-infected subjects among Spanish opiate users. Prevalence of neuropsychiatric and cardiopulmonary problems in other drug subgroups was similar to those reported in the literature.[10]

It is important to highlight special features of emergency room data that allowed the present estimate calculation. When data were analyzed as a whole,

none except the saturated model fit the data well. However, for all subgroupings according to other drugs used, independent models offered a deviance difficult to improve; in fact, traditionally used criteria to choose models (AIC) would have selected those models.[32] Even so, and according to suggestions of some authors,[34] we chose the estimate provided by the saturated model whenever possible because in the complete model goodness of fit improved on the inclusion of interactions between period samples. Moreover, from previous studies, we knew that illegal drug consumers have a tendency to repeatedly visit emergency rooms,[25] thus samples would not be independent.

One of the problems, at least for one of the subgroups, was the low frequency of consecutive emergency room visits during the year. The existence of consecutive visits is probably related to the type of problem leading to emergency room attendance, which in turn may be related to the drug consumed and the route of administration. Injectors have higher rates of positive HIV status, with an increased risk of organic problems that may lead them to be high frequenters. Some other routes may be more associated with less-common health problems (e.g., related to mental health), decreasing the possibility of finding repeaters. These facts could also be related to patients' visibility in hospital emergencies, but in our case, differences in subgroup visibility seemed more related to which models were used for estimates.

In the present application of capture–recapture, case definition was the same for the different samples as they came from a single source. Emergency contact with health services does not retain subjects for long periods, allowing them to be considered in following captures. Also, using data from a single year, violation of the capture–recapture closed population assumption was not a serious issue. However, some special features of emergency room data could limit our results. Data were collected from hospital emergency records in which professionals write patient characteristics and behaviors considered clinically relevant for that emergency. Validity and reliability of such data have been analyzed in previous studies and found to substantially underestimate the number of cases detected .[26,42,43] The overlooking of cocaine use in myocardial infarctions of young adults (younger than 45 years), 25% of which could be attributed to cocaine use,[44] would probably lead to an underestimate of cocaine users through our emergency room capture–recapture.

We have mentioned one of the facts that could lead to an underascertainment in the number of cases seen in hospital emergencies, but there are two other factors that could also contribute. First, some consumers would not appear in public emergency rooms (i.e., high socioeconomic group users); this has already been discussed in other articles on illegal drug use prevalence estimates.[28] The second factor relates to health services provision within the city. In fact, in 1999 coverage of psychiatric emergencies (one of the more frequent reasons for attendance) was still incomplete for some city neighborhoods. It would be especially important for the Old City (Ciutat Vella) area, where consumption prevalence was high (data not shown), but psychiatric services had to be sought outside the city. As a whole for cocaine, coverage of selected emergency rooms in the present study would be lower than that previously observed (95%) for opiate-related emergencies in the same centers.[25] Thus, even if our estimate for problematic cocaine use is quite high, it is probably an underestimate. Furthermore, it would only account for users with patterns of use that tend to lead them to seek emergency room assistance. Confidence intervals, although wide, do not account for bias related to capture appraisal.

Other problems limiting the validity of some results may be related to incompleteness of patients' characteristics reported in medical records; this could affect

prevalence of some variables, with HIV status one of them.[45] In our study, route of administration misreporting could have been important, although finally we did not use this variable to control for heterogeneity, preferring other drugs consumed instead. However, we have no information about how much underreporting of other drugs consumed could be present. This would affect the classification into subgroups, and we are especially concerned about the cocaine-alone subgroup. Within this subgroup, there was a variety of user types and patient characteristics that did not correspond to those of cocaine-alone abusers detected in treatment admissions.[39] In the light of a previous study describing the "compulsive-dysfunctional" type,[38] the data could be accurate. The compulsive-dysfunctional type admits both the pure cocaine addict, who primarily uses the intranasal route, and the ex-heroin addict, who substitutes heroin with cocaine as his basic drug, but continues to inject it. However, the fact that a large number of users in the cocaine-alone profile were found in the SIDB could either indicate that they were ex-heroin users who at present only use cocaine or heroin addicts also consuming cocaine whose heroin use was not registered in the emergency room medical record.

The high prevalence encountered and specific problems detected ought to lead public health officers to plan adequate treatment and preventive strategies. The possibility to use a single list for capture–recapture analysis should be noted by urban health researchers to find alternative ways to fill gaps in information about relevant elusive health problems.

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